CRAYFISHES OF THE CHEAT RIVER WATERSHED IN WEST VIRGINIA AND PENNSYLVANIA. PART II. OBSERVATIONS UPON ECOLOGICAL FACTORS RELATING TO DISTRIBUTION[1]

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Schwartz and Meredith (1960) presented as Part I the localities and species of crayfishes (Decapoda) currently found throughout the Cheat River watershed of West Virginia and Pennsylvania. These records indicated that two species, *Cambarus bartoni* and *Orconectes obscurus*, now occupy the Cheat system. Literature records occur for *Cambarus bartoni carinirostris* (Faxon, 1914; Ortmann, 1931) and *Cambarus carolinus* (Ortmann, 1931) in addition to the forms mentioned.

Bick et al. (1953) have reviewed the meager literature relating to the ecology of acid mine streams. Bowden (1961) has called attention to the effects of strip mines on faunal ecologies. The former have also shown the detrimental effects to the fauna and ecology of a Louisiana acid stream after it was altered by channel dredging.

A casual scanning of the data will reveal peculiarities in the distributions of the present species. *C. bartoni*, although taken at 138 stations of the 233 sampled (fig. 1), is absent today from the central portion and a number of the tributaries of the Cheat system. The greatest number of collections was made in the headwaters of the system. *O. obscurus* (fig. 2) occurs in only a few of the lower elevation streams, and was absent from the headwaters and central zone of the watershed. *C. b. carinirostris* (fig. 1), a species once described from the Cheat system and whose center of abundance was believed to be in the Cheat system streams of Randolph, Tucker, and Pocahontas counties (Faxon, 1914), was not found during the present study. *C. carolinus* (fig. 2), also known in the literature (Ortmann, 1931) from the Cooper's Rock area, now Cheat Lake, and Parsons in Tucker County, was also absent from the samples.

What has happened within the watershed to cause the deletion of two forms and the restriction of the remaining two to such narrow or limited areas of the system? What ecological factors are present today that were perhaps absent previously that may be influencing the species distributions and/or abundance? What is the possible future of the crayfishes and their distributions in this watershed? These questions are the basis for Part II which will be an attempt to review the ecological changes in this watershed and to note the interactions that have been and are taking place with regard to crayfishes. These effects have affected the distribution and abundance of many other organisms that inhabit these waters (Schwartz and Meredith, 1962).

CHEAT WATERSHED

Past

The Cheat watershed has been in existence some 100,000,000 years or since the formation of the Appalachian Mountain system during the Mesozoic (Gamow, 1941). Modern man, however, has been on the scene only some 25,000 years (Wells and Wells, 1956) while the white man's influence on the Cheat watershed

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dates from 1754 (Callaghan, 1923; Robinson, 1956). As early as the Cambrian period of the Paleozoic era the hard rock base adjoining West Virginia extended as a land mass over most of northern Canada and as a narrow strip down through New York, across southeastern Pennsylvania and into Alabama (Leighton, 1936). To the west a great inland sea covered North America and West Virginia. Part of the Paleozoic streams, therefore, must have drained south into this sea while the rest must have flowed northward out through the Laurentian River to the Atlantic Ocean (Flint, 1947). The Cheat drainage, according to Leverett (1902, 1921, 1942) was part of the Middle Ohio system that flowed with other West Virginia streams (west of the mountains) north, via the Beaver River to join the

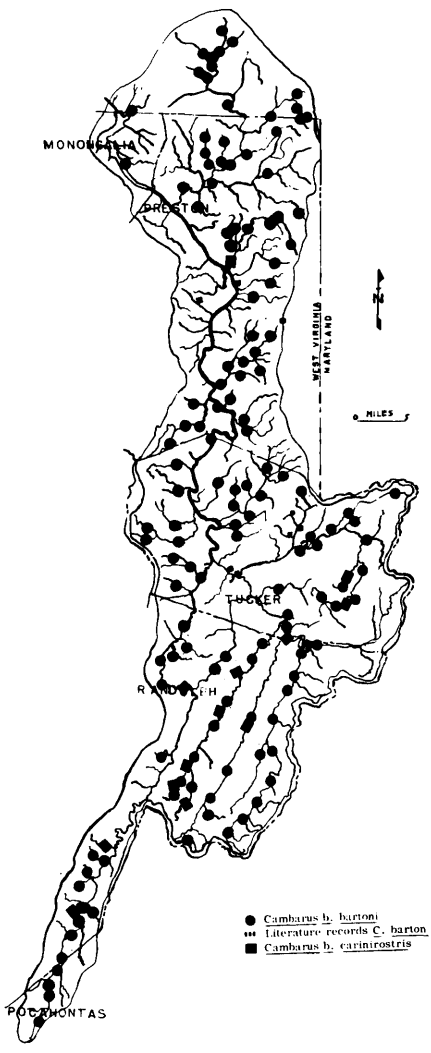

FIGURE 1. Distribution of *Cambarus b. bartoni* and *C. b. carinirostris* within the Cheat River watershed in 1956 from observations and literature records.

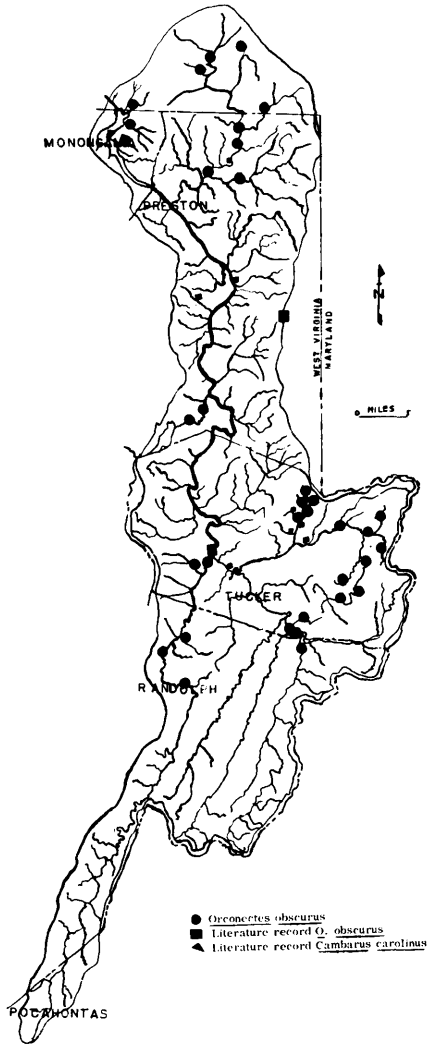

FIGURE 2. Distribution of *Orconectes obscurus* and *Cambarus carolinus* within the Cheat River watershed in 1956 from observations and literature records.

Laurentian River, and east into the Atlantic Ocean. The remaining West Virginia streams, west of the mountains, flowed northwest via the Teays-Maumee River system that joined the Laurentian River somewhere near the present Great Lakes (Fidlar, 1943; Janssen, 1953; Stout et al., 1953).

During the interval, until the close of the Tertiary, the land of the Cheat system was thrown upwards into mountains and eroded four times. With the close of the Tertiary, the whole northern portion of the United States was subjected to large temperature oscillations (Emiliani, 1955) which culminated in four large glaciated ice sheet intrusions from Canada. Although these glaciers never advanced into West Virginia (Leverett, 1902) their effects on the Cheat drainage must be noted. The principal effect was upon the pre-glacial middle Ohio-Allegheny River drainage system. Here the ice sheets and debris impounded the northeast-flowing Laurentian River (Radforth, 1944) and finally with their retreat encouraged waters of the upper Allegheny and Middle Ohio to break across cols and flow southward (Leverett, 1902) into the existing lower Ohio River. Individual stream captures within this drainage, during this early developmental period, were few or nil as compared with recent years (Campbell, 1896; Davis, 1899; Leverett, 1902). In general, the Cheat has remained unchanged from the Cretaceous to the present in its outline and flow to the north, only the point of discharge has been changed. The Cheat River system, therefore, is as old as the hills supporting it. However, its present development of stream courses and conditions (fig. 3) appears as young and wild as when it began its existence.

Present

General description.—The Cheat River, which received its name from the Indians who called it "The Cheat" because of its depth-deceiving black waters (Callaghan, 1923), occupies a drainage basin that comprises some one-seventeenth of West Virginia's total land mass and drains an area of 1,424 square miles (Anon., 1942; Schwartz and Meredith, 1960, fig. 1). The Cheat River is the second largest tributary of the Monongahela River system while the Youghiogheny River to the north and east is the longest tributary. Cheat River joins the Monongahela River at Point Marion, Pennsylvania, some 89 miles above the head of the Ohio River at Pittsburgh, Pennsylvania.

The Cheat basin is located in the Allegheny Mountain region of the Appalachian Plateau Province (Ortmann, 1913). Specifically, Randolph and Pocahontas county headwater areas lie in the Cumberland Plateau while the true Appalachian Mountain system lies to the east. The northern sections of Preston, Monongalia, and Tucker counties lie in the Allegheny Plateau division of the Province (Darton and Taff, 1896; Ortmann, 1913).

The Appalachian Plateau Province is characterized by bold parallel ridges which are separated by mature valleys. The average elevation of the ridge crests is about 3,500 ft and the average relief over the entire basin is approximately 2,000 ft (U. S. Geol. & Geod. Quad. Maps). The relief ranged between the elevations of 778 ft at Point Marion, Pennsylvania, where the Cheat joins the Monongahela River, to a maximum elevation of 4,842 ft on Bald Knob in the southern part of the basin (Reger, 1931).

Tributaries.—The Cheat River is formed at Parsons, West Virginia, Tucker County, by the confluence of two large tributaries: Shavers Fork and Black Fork rivers. Shavers Fork is a single entity while Black Fork is composed of five subtributaries which run generally north and south and are Glady Fork, Laurel Fork, Gandy Creek, Blackwater River, and Dry Fork River.

Cheat River below Parsons flows north over its old beds through Tucker County, receiving such tributaries as Clover and Horseshoe Runs. In Preston County, Buffalo Creek, Saltlick Run, Roaring River, Muddy Creek, and Big Sandy Creek add to the Cheat's volume. Table 1 summarizes the relations of

tributary length, drainage, and percent to the Cheat drainage. Note that Shavers Fork (15.2 percent), Big Sandy Creek (14.6 percent), Blackwater River (9.8 percent), and Dry Fork River (7.9 percent) are the major tributaries of the system.

Gradients.—Figure 3 illustrates the high gradients for most of the small tributaries as well as for Shavers Fork and Black Fork rivers. One can see why Shavers Fork to Bowden, West Virginia, lies within a narrow, sheer-walled gorge some 1,200 ft deep. The same is true for Glady Fork and Laurel Fork rivers which are inaccessible except for an occasional road or trail. Dry Fork is a river of moderate

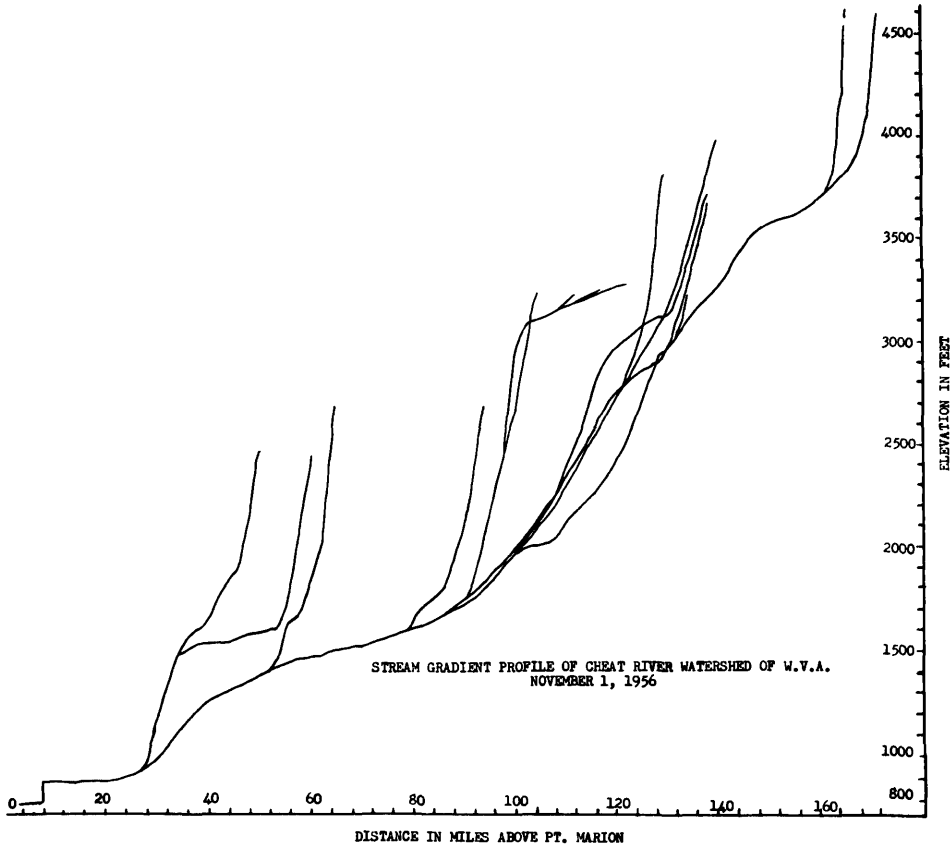

FIGURE 3. Stream gradient profile of the Cheat River watershed, West Virginia and Pennsylvania.

gradient and is penetrated by many roads and trails which cross it. Blackwater River, however, lying northeast and south of Davis, West Virginia, runs through a cut-over, burnt-out section of land some 26 square miles in area (13 miles long by 2 miles wide) and is accessible only by foot. Below the Blackwater Falls, west of Davis, West Virginia, the river to Hendricks, West Virginia, likewise roars through a sheer-walled gorge after receiving the North Fork of the Blackwater River south of Douglas, West Virginia.

North of Parsons, West Virginia, the Cheat River meanders considerably on its way to Rowlesburg, West Virginia. North of Rowlesburg, the Cheat River to Kingwood is a raging torrent which pools out only a short distance below Albright,

West Virginia. The river from Albright to Cheat Lake flows through a deep gorge and receives Bull Run and Big Sandy Creek as tributaries. On reaching Cheat Lake, which is formed by a dam 3 miles southeast of Point Marion, Pennsylvania, the river flows through 13 miles of impounded water ½ to ¾ mile wide to drop 81 ft at the dam. There is little fall (fig. 3) from the dam to Point Marion and the junction of the Cheat with the Monongahela River. Table 1 summarizes the stream gradient data in the Cheat River from its source to Point Marion and, coupled with figure 3 (Stream profile), vividly portrays the rugged and wild nature of this water system.

Natural barriers.—Natural barriers occur throughout the systems in a number of forms: a) waterfalls on the Blackwater River (80 ft) near Davis, West Virginia, a prolonged ¼-mile series of falls of 200 ft in Big Sandy Creek at Big Sandy, Preston County; a waterfall at Shavers Fork (40 ft) 15 miles south of Bemis, West Virginia; b) sinks such as the Sinks of Gandy on Gandy Creek which passes for ¾ mile through a mountain to drop a distance of 180 ft; c) deep walled gorges to Blackwater River which drops 1,200 ft in five miles, similar gorges on Laurel Fork, Gandy Creek, and the Upper Shavers Fork south of Bemis, and the Cheat River between Rowlesburg and Kingwood and Kingwood to Cheat Lake.

Man-made barriers.—These exist in the form of dams at Point Marion to Cheat Lake 100 ft high; Bruceton Mills 20-ft dam to Big Sandy Creek at Bruceton Mills, West Virginia; a 60-ft dam on Cheat River at Albright; and a 3-ft dam on the Shavers Fork headwaters at Spruce.

Precipitation.—Few records are available for the amount of rainfall over the Cheat drainage. In general, the annual rainfall at observation points within the watershed is about 45 in. (a mixture of rain, dew, and fog) with some indications that it may have averaged 50 in. during the 1800's. The higher elevations, where observations are more sparse, receive more rain than the lower elevations to the north (Anon. 1951, 1952, 1953, 1954, 1955, 1956).

In terms of snow, where the records are even fewer, the general trend is for about 8 percent of the total yearly precipitation to be in the form of snow (Anon. 1941) or about 70 in. of snowfall per year. This means that higher elevations in such areas as Canaan Valley and the Blackwater River often receive annual snow falls well in excess of 70 in. Horton, West Virginia, has received as much as 122 in. per year (Reger, 1931).

Runoff and discharge.—Although the most reliable figures are some 30 years old, little change in the average runoff rate of 28 in. per year (Anon. 1941, 1955) has been noted. Shavers Fork has a high discharge rate as the result of 45 or more in. of rain or snow accumulation per year. The maximum and minimum recorded discharge rate for Shavers Fork occurred May 12, 1924, and October 7, 1924, when 14,800 sec-ft and 1 sec-ft of water, respectively, were discharged at Parsons, West Virginia. The maximum discharge recorded at Cheat Lake was 55,600 ft^3/sec on March 18, 1936, and the average river discharge of 2,200 ft^3/sec /day is subject to wide fluctuations throughout the year.

Geology and soils.—Generally sandstone, shale, coal, and limestone deposits underlie the entire Cheat watershed. Specifically, the Shavers Fork area is underlaid by the Kanawha and New River series of Pennsylvania shales and sandstone. This area extends from the headwaters to Bowden, West Virginia, and from there to St. George to include Horseshoe Run. The rest of Shavers Fork and the main Cheat is underlaid by Devonian Chemung fossiliferous shale and sandstone. Glady Fork is also within the Chemung field. Laurel Fork is influenced by Devonian Catskill sandstones. Gandy Creek is subject to parent material of the Chemung type while the Blackwater system and Red Creek areas are underlaid by Mauch Chunk (red or green sandstone formation), Greenbrier limestone, and Allegheny and Conomaugh coal deposits.

Cheat River from St. George to Rowlesburg, West Virginia, including the

Saltlick system, is influenced by Catskill and Chemung sandstones. The Rowlesburg to Albright, West Virginia areas of the Cheat River lie near Conomaugh, Pottsville, and Allegheny sandstone and coal deposits. From the Big Sandy Creek entry to the Cheat's junction with the Monongahela River at Point Marion, Pennsylvania, the parent material consists of Monongahela and Allegheny coal and sandstone (Geol. Surv. Map of W. Va., 1934).

The present cover of podzol and podzolic soils overlying the parent material is the result of the decomposition of the above parent materials throughout the basin and the effect of many years of rainfall and erosion. The podzol soils are of the Dekalb-Leetonia silty loam variety while the podzolic soils consist of the Westmoreland and Muskingum-Wellston-Zanesville types. The podzols occur at elevations of 1,500 to 3,000 ft or where there is an average of 35 to 40 in. of rain, high humidity, low evaporation rate, much fog and cloudy weather (Anon., 1938). This fits a belt of land covering Pocahontas, Randolph, Tucker and the southeastern half of Preston counties and the Cheat Lake area of Preston and Monongalia counties. Podzolics occur at elevations of 800 to 1,500 ft and in an area of 38 to 46 in. of rain with the specific Muskingum-Wellston-Zanesville soils existing at 500 to 1,500-ft elevations in the region of Preston County.

Generally, these soils are slightly acid except where influenced by limestone formations. Limestone deposits occur in the greatest quantities in Pocahontas and Randolph counties where alkaline conditions would normally be expected. However, due to the acidic nature of the soils over which the tributaries of this area flow, a large amount of natural acid is contributed to the streams south of Parsons. That is, an "acid belt" of land extends in a general north-to-south direction, rising in the south and southwest side of Canaan Mountain and in the north and east side of McGowan Mountain, with a small section on the east side of Cheat Mountain from Bemis to the falls of Shavers Fork (McGavock and Davis, 1935) which is characterized by a layer, lying at a 45° angle, of soft calcareous shale rich in iron and copper pyrites (Mauch Chunk) and other minerals containing sulfur. This soil is very loose and porous and readily absorbs large quantities of surface water which, with its high oxygen content, causes oxidation and results in the formation of sulfuric acid in the same manner as in abandoned coal mines. This interplay of acid belt and limestone can be seen in Otter Creek on McGowan Mountain where the stream comes tumbling down at a rate of 144.6 ft/mile over the highly acidic "acid belt," then passes over a limestone formation to enter Dry Fork nearly neutral.

Man and the Cheat basin.—Callaghan (1923) cites that the first known white settler arrived in the Cheat Valley in 1754 while Mooreland (1940) states that he did not arrive until 1772 and settled near what is now Cheat Lake Either way, by 1798 the white man was occupying the northern edges of the Cheat Valley and settlement was stimulated by an iron works started near Mount Chateau, which by 1848 employed 2,500 people. Today, however, some 200 years after the first settling, only 46,000 people live within its bounds.

Callaghan (1923) notes that man from 1840 to 1913 lumbered over the entire Cheat basin and denuded it of its best stands of wood. The worst and most disastrous effect of this onslaught can still be seen in the Blackwater River's Canaan Valley where fine spruce trees were stripped and burned to such an extent that even a century later the only regrowth has been from planted trees (Robinson, 1953). Some idea of the vastness of this denudation can be noted from a conversation I had with an oldtimer of Jenningston, West Virginia, (then Raines) wherein he related how 38 railway carloads of wood left the Laurel Creek area every day for 47 years.

Man has influenced the Cheat Valley in one other devastating way by mining coal for 61 years. Coal exists in Canaan Valley in the region of Pendleton and North Fork creeks and to the west of Cheat River below Rowlesburg and Kingwood

in the Tunnelton area. Coal strata also exist in still greater abundance near the towns of Kingwood and Canyon, West Virginia, where strip mines and deep mines are in operation.

The Cheat from 1784 to 1929.—The Ohio River north of Point Marion, Pennsylvania was noted by Rafinesque (1820) and Kirtland (1841) as clear and beautiful. The Cheat River, however, as described by George Washington, September 24, 1784, (Moreland, 1930) was:

> The Cheat at the mouth is about 125 yards wide—the Monongahela near double that—the colour of the waters is very different, that of the Cheat is dark (occasioned as is conjectured by the Laurel, among which it rised, and through which it runs); the other is clear, and there appears a repugnancy in both to mix, as there is a plain line of division between the two for some distance below the fork; which holds, I am told near a mile—the Cheat keeps to the right shore as it descends, and the other to the left.

Howard in 1874 (Anon. 1956), in describing the Blackwater River says the "Blackwater River is very dark though clear. Red Creek is a very red color, which I attributed to iron in the soil, but afterwards to the hemlock and rhodendron juices. Dry Fork below the Blackwater was very black in 1875." Ortmann (1913), while collecting mussels and aquatic snails noted, "Collected at Parsons in Shavers Fork, below which is badly polluted. Dry Fork is polluted by the Blackwater River." Since these early times many other writers have called attention to the polluted or color conditions of the Cheat: Rafinesque (1820), Johnson (1905), Hennen and Regar (1913, 1914), Faxon (1914), Carpenter and Herndon (1929), Ortmann (1931), Reger (1931), Fidlar (1943), Janssen (1953), and Anon. (1956). Unfortunately, chemical samples were not made of the Cheat River waters by the early settlers, wanderers, and scientists.

Cheat River in 1925.—Carpenter and Herndon's (1929) publication of the Cheat River pollution survey is the only comprehensive work on any basin in West Virginia. Herndon's doctoral thesis (1934), primarily on acid mine problems, and Hodges' (1938) work are the only other major works on West Virginia waters. Carpenter and Herndon (1929) (fig. 4) note no major pollution entering Shavers Fork south of Parsons. This was largely a result of the ruggedness of the area discouraging much rural or urban development. They noted, however, six coal mines operating between Bemis and Hopkins (North of Cheat Bridge) where now only one exists. Shavers Fork had a pH of 7.0 to 7.2 and an oxygen saturation of 62 to 84 percent. Dry Fork was, "at all times during the survey is very good," while during low-water stages the stream still had plenty of oxygen (57 to 89 percent saturation) and a pH of 6.5 to 7.6. The Blackwater River was, "in sharp contrast to the clear waters of Shavers Fork and Dry Fork. The color of the Blackfork River is a dark reddish brown, apparently due to the tannic acid from the hemlock and spruce which grow in great abundance in the Canaan Valley combined with iron oxide from the red Mauck Chunk shales that compose the principle portion of the sedimentary deposits." Eighteen mines were draining into the North Fork area of the Blackwater River and contributed (1929) 1,400,000 gal of acid mine waste with a pH of 2.8. The effect of this upon the Blackwater River at Hendricks, West Virginia, produced a pH of 3.0 to 4.6. The Dry Fork from Hendricks to Parsons, West Virginia, was so greatly influenced by the Blackwater's entry that on dilution this section of stream, the Black Fork, possessed a pH of 3.4 to 6.0 and 56 to 95 percent oxygen saturation.

Cheat River, north of Parsons, a blending of Shavers Fork and Black Fork rivers, possessed a pH of 6.9 and 86 percent oxygen saturation. This was further reduced near Rowlesburg to a pH of 4.3 and oxygen saturation of 78 percent. In the gorge north of Rowlesburg these values rose to pH 6.6 and 85 percent oxygen saturation.

Cheat River in 1948.—A striking change can be noted on comparing the raw

pH data of the West Virginia State Water Commission Survey (fig. 5) with that of Carpenter and Herndon (fig. 4). The pH in the entire basin is more acidic with a 19 year lapse of time, rather than alkaline, while the oxygen percent saturation has remained virtually the same (70 to 100 percent). The increased acidity (1948) occurred from Pringle Run to Morgan Run in the areas of Kingwood and Tunnelton, West Virginia. Coal field activity has sent Muddy Creek's pH from 6.5 (1929) to 4.0 (1948) while coal fields near Bull Run and Canyon, West Virginia, have permanently destroyed most aquatic life in these streams, annual (1956) pH is 2.5.

Cheat watershed in 1956.—One hundred thirty-two (fig. 6) stations were established throughout the watershed mainly on the basis of position, accessibility and

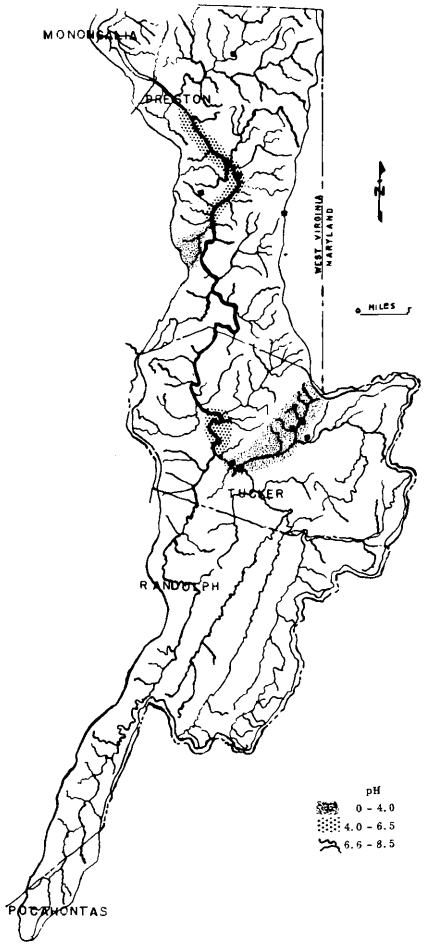

FIGURE 4. Stream pH conditions adopted from the 1929 Pollution Survey by Carpenter and Herndon.

drainage. These 132 stations were sampled once each during the winter (December and January) and summer (July and August) months. Seven of these stations (fig. 6) were pinpointed for further study when monthly 24-hr chemical analyses at 4-hr intervals were made during 1956, and corroborated by data taken over the general watershed.

A quick glance at figures 7 and 8 readily shows why few crayfish, fish, or other forms of life exist in the central zone of the Cheat watershed. Note that the major sources of pollution are (table 2) tributaries full of acid mine wastes. Winter

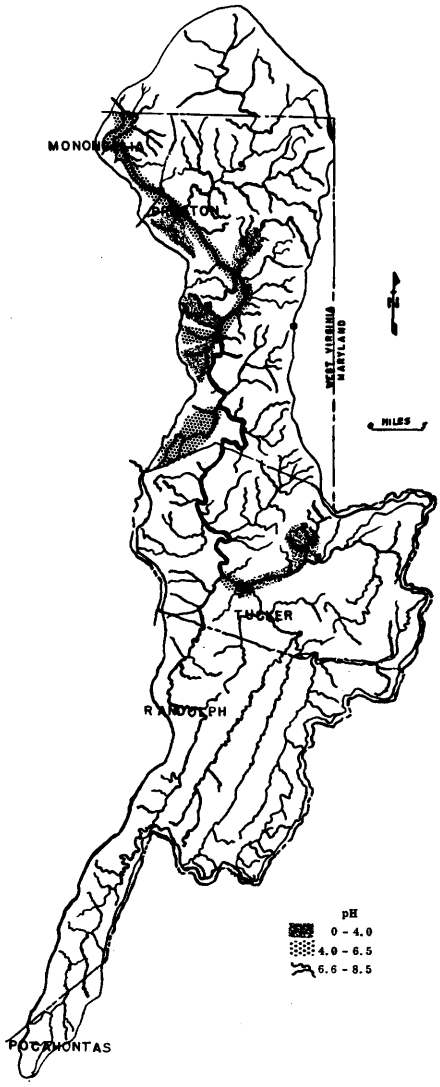

FIGURE 5. Stream pH conditions adopted from 1948 data collected by the West Virginia State Water Commission.

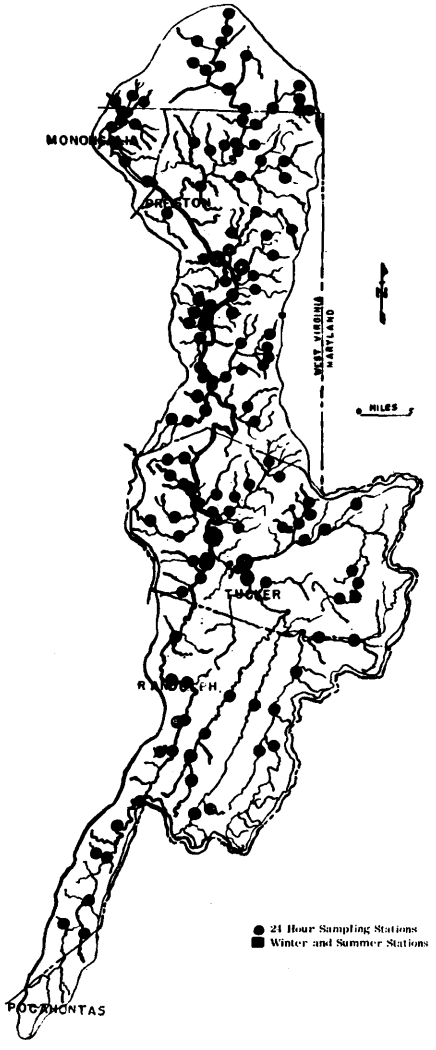

FIGURE 6. The 132 limnological sampling stations sampled winter and summer, 7 tracked monthly on a 24-hr basis.

conditions (fig. 7) illustrate that north of Parsons all the accumulated sludge, acid waste, etc., that has been trapped in pockets of shallow water, are discharged or washed down into the Cheat River by the fall rains. This creates a zone between Pringle Run to Point Marion, Pennsylvania, where the pH is less than 4.0, a condition which persists over a period of 6 to 8 months (October to March). This is an important observation as Ellis (1937, 1944), Ellis et al. (1946), Lagler (1950), and Overstreet and Dean (1951) note that if pH values lower than 5.5 (0 to 5.5) persist for long periods of time, this condition is, or may be, lethal to most forms of aquatic life. Generally, between December and February a pH above 5.5 exists in the tributaries north of Parsons.

Summer pH values greater than 6.4 (fig. 8) are the result of slower moving water, plant activity, and less discharge into the system. The alkaline waters south of Parsons can be seen influencing the clean-up of the Cheat River north to a point near the entry of Pringle Run (fig. 8).

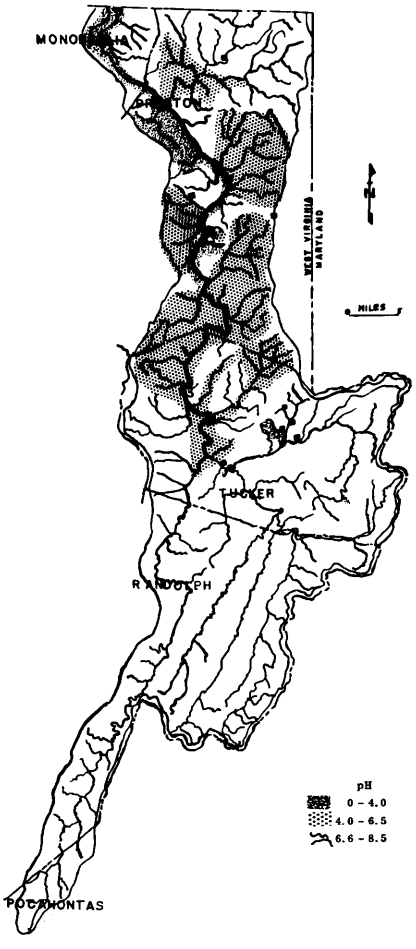

FIGURE 7. Winter (1955–56) stream pH conditions.

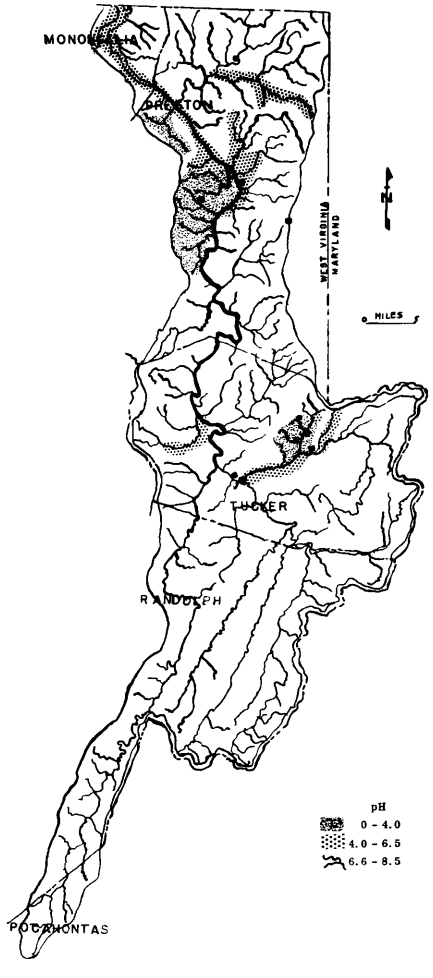

FIGURE 8. Summer (1955) stream pH conditions.

Figure 9 illustrates the yearly mean pH values at the seven key tracking stations plus Bull Run. Lower pH's become more evident during both seasons as one moves downstream from clear into highly polluted waters.

Oxygen saturation was always 70 percent or more, reaching, at one point in the Cheat River at Albright, a 252 percent saturation (30.86 ppm) in February. The lowest oxygen content recorded was 0.15 ppm in Muddy Creek during June of 1956.

Natural water temperatures ranged from 0° C in winter to 20° C in summer.

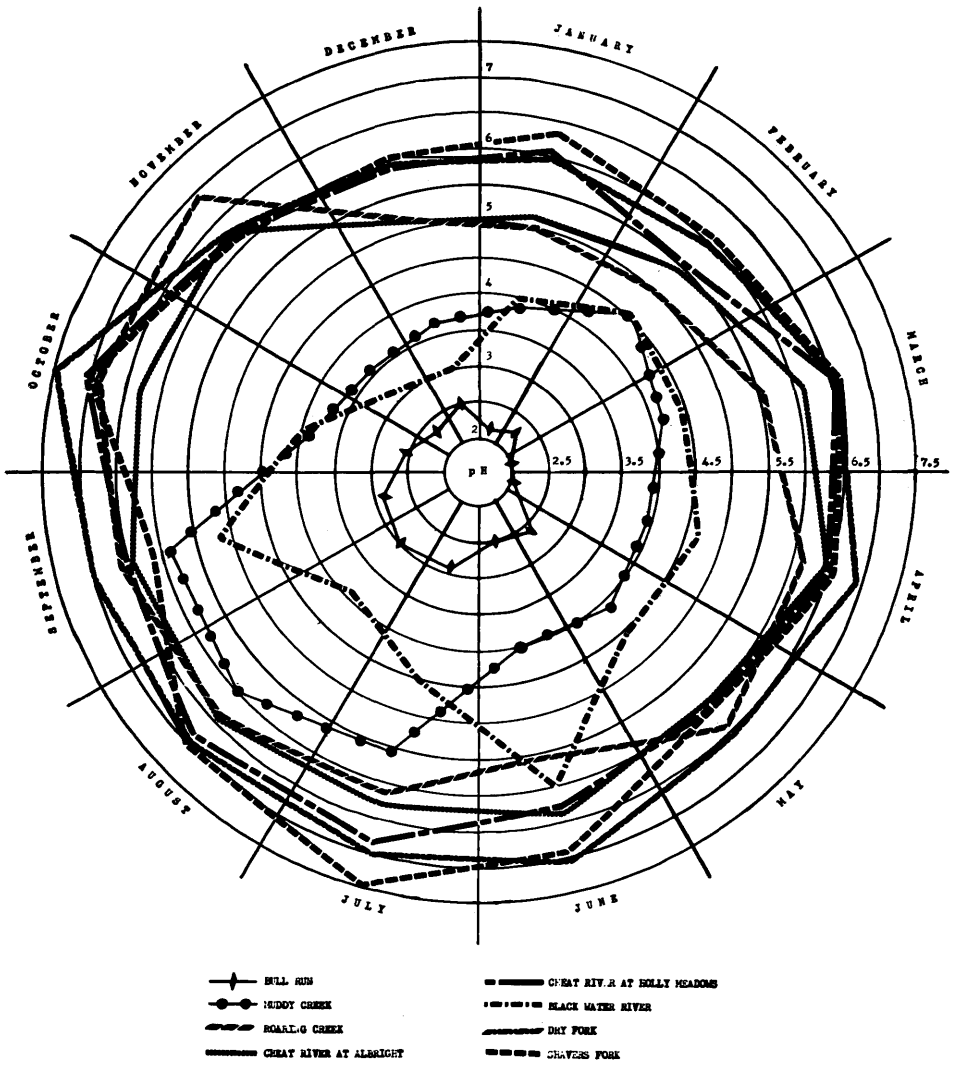

FIGURE 9. Monthly mean pH values recorded from 7 key tracking stations, plus Bull Run, located in the Cheat River watershed.

Ecological Interaction

From the foregoing, we have shown that the Cheat River watershed, in a relatively short period of time, has been transformed and its value as an aquatic habitat destroyed by man's activities. Stream conditions, such as pH, have grown worse with each year and undoubtedly will become even more so in the near future. Crayfishes, such as the species captured, have been one of the best indicators of the results of man's activities in the Cheat Valley. They have been either destroyed from that (central) portion where the environmental conditions are the poorest, or have been restricted to the higher and cleaner portions of the system.

O. obscurus, a large river or stream form which is easily restricted by the rushing water of falls and rapids (Ortmann, 1905), will presumably be completely eliminated, except for those areas of Big Sandy Creek and Shavers Fork where it now exists. The presence of *O. obscurus* in the upper Cheat system suggests that, stream gradients years ago were not as rugged as they are today and that with the gorges that now exist, it has been cut off from the lower sections of the system naturally as well as through the present polluted character of the watershed.

C. bartoni, a species of cooler waters and smaller streams, will continue to be restricted in its distribution to the tributaries and cleaner waters of the Cheat. Note (fig. 1) areas of extreme pollution are devoid of *C. bartoni* while few collections of this species were obtained where streams possessed a pH of 4 to 6.5. Note also that even in that zone delineated as possessing a pH of 4 to 6.5, collections of *C. bartoni* were usually obtained towards the headwaters of these tributaries.

C. b. carinirostris is a species which perhaps tolerated less rugged stream conditions. We cannot explain the disappearance of this species from the relatively clear waters of the tributaries south of Parsons, such as Shavers Fork, Laurel Creek, Gandy Creek and the Blackwater River south of Davis, West Virginia, where it once abounded. The former statement, however, appears unlikely since the streams just mentioned have not changed much in ruggedness since *C. b. carinirostris* was taken by Hay in 1899 (Faxon, 1914). As pointed out by Schwartz and Meredith (1960) the taxonomic status of this subspecies warrants further study as to verification. Such a study may show that *C. b. carinirostris* was nothing more than an aberrant *C. bartoni*.

C. carolinus is a mountain stream form that has apparently been eliminated from Coopers Rock (Ortmann, 1931) by the construction of Cheat Lake. Its absence from Parsons, West Virginia, (Ortmann, 1931) cannot be explained at this time.

SUMMARY

A review of the Cheat River watershed from its origin to the present with respect to its formation and changing environmental and physical characters has shown that the crayfishes (and the same can be said for other organisms) have been either destroyed or restricted in their distributions and abundance by destructive natural and, to a larger extent, man-made influences. The latter, in the form of acid mine and lumber pollution, has or will permanently destroy satisfactory aquatic environments in whole sections of this stream system. The future, if man's influences are not changed, will be one of complete elimination of the decapods and most, if not all, other aquatic organisms.

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